Operating Experience Weekly Summary 99-24

June 11 - June 17, 1999

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EVENTS

1. LABORER HOSPITALIZED AFTER RECEIVING 480-V SHOCK

On June 14, 1999, at the Strategic Petroleum Reserves Big Hill Site, a subcontractor laborer received an electrical shock when she inadvertently contacted an energized feeder cable bus inside a 480-V motor control center. The laborer was tagging cables that were in the bottom of a power distribution center panel when part of her body contacted the feeder cable bus. A nearby employee saw the event and called the emergency response team. Site electricians de-energized the motor control center and a subcontractor employee dislodged the laborer from the feeder cable bus. Emergency response team personnel administered first aid and assisted in transporting the laborer to an air-ambulance, which flew her to an area hospital. The laborer was treated and released from the hospital approximately three days later. The site manager suspended subcontractor electrical work in the motor control center and directed personnel to cordon off the area. A Type C Accident Investigation is underway. OEAF engineers will follow the accident investigation and provide information as it becomes available. (ORPS Report HQ--SPR-BH-1999-0004)

KEYWORDS: electrical maintenance, shock, injury

FUNCTIONAL AREAS: Electrical Maintenance, Industrial Safety

2. UNDERGROUND POWER LINE CUT

On June 10, 1999, at the Idaho National Engineering and Environmental Laboratory, a subcontractor equipment operator struck an underground, single-phase, 7.2-kV power line with a bulldozer, causing a power outage at a communications facility. The operator struck the power line while grading an area to make a level spot inside a fenced electrical equipment area on which to place a construction trailer. The grading was not in the planned scope of work for the operator. The power line was owned by Utah Power and Light and was buried approximately 3 in. below ground level. Although this occurrence did not cause injuries, disturbing underground utilities reduces safety margins and can interrupt vital services. (ORPS Report ID--LITC-CFA-1999-0005)

Investigators determined that Utah Power and Light had installed the power line at the request of DOE to provide power to the communications facility. Utah Power and Light installed some portions of the line above ground and some below ground. The power line was installed below ground where it ran through the fenced area. Investigators determined that the subcontractors had a survey of underground utilities in the fenced area, but they did not expect to encounter the power line so near the surface. They also determined that a spotter was assigned to help the operator. The spotter saw the cable coming out of the ground and ordered the operator to stop, but the warning came too late to prevent the bulldozer from breaking the cable. A standby diesel generator immediately started and the job supervisor requested a utility repair crew to repair the power line. The facility manager has not determined corrective actions.

NFS has reported on other excavation occurrences in which subcontractor work scope violations resulted in damage to underground utilities in several Weekly Summaries. Following are some examples.

- Weekly Summary 99-10 reported that a construction subcontractor operating a track-hoe at the National Renewable Energy Laboratory struck and ruptured a 2-in. natural gas distribution line. He had failed to follow a project manager's instructions ragarding the excavation boundaries and was working in an area that should have been excavated by hand. (ORPS Report CH-NA-NREL-NREL-1999-0001)

- Weekly Summary 98-34 reported that a trenching machine operator struck and severed a 1-in. natural gas pipeline at the Los Alamos National Laboratory. Investigators determined that the construction contractor had not conducted the work in accordance with contract provisions because he did not maintain a red-line drawing at the work site showing underground utilities relative to site benchmarks. They also determined that he did not direct workers to hand-excavate within 5 ft of utilities and did not consult site utility locator personnel before excavation began, as required by the activity hazard analysis. (ORPS Report ALO--LA-LANL-ADOADMIN-1998-0005)

These occurrences underscore the importance of job planning, subcontractor control, and conducting thorough subsurface surveys before beginning earthmoving activities. Even when operators believe that their activities will only minimally disturb the soil, it is possible for utilities to exist at very shallow depths.

OSHA 29 CFR 1926, *Safety and Health Regulations for Construction,* subparts .651(b) and .651(a)(3), assigns employers responsibility for identifying underground hazards near a work area. The requirements of 29 CFR 1926.965(c) state that work must be conducted in a manner that avoids damage to underground facilities. Similarly, work must be performed in a manner that protects the workers.

Other sources for excavation safety information include the following.

- Hanford Lessons Learned No. 1998-RL-HNF-0026, available at http//www.hanford.gov/lessons/sitell/1998/199826.htm. This document provides the lessons learned from two excavation occurrences at Hanford and describes the bases for the Hanford excavation safety program. Included in it are criteria for obtaining permits, requirements for locating utilities, and descriptions of when hand-digging is required.

- OSHA information on trenching and excavation is available at http://www.osha-slc.gov/SLTC/trenchingexcavation/index.html.

KEYWORDS: cable, industrial safety, underground, utility

FUNCTIONAL AREAS: Construction, Industrial Safety

3. CHEMICAL TRUCK CONTAINING CAUSTIC CONNECTED TO ACID STORAGE TANK

This week, OEAF engineers reviewed a near-miss event at a commercial nuclear power station. On March 9, 1999, a plant equipment operator and an operator trainee allowed the driver of a chemical tank truck to connect the truck, which contained 4,000 gal of sodium hydroxide, to a partially full sulfuric acid storage tank. The driver had inadvertently misinformed plant security officers about the contents of the shipment by telling them the truck contained “caustic acid”, and the security officers repeated this information by notifying control room personnel that “acid” had arrived on site. When the operators discovered the error before the chemical transfer began, they had the driver disconnect the truck from the acid tank. If the sodium hydroxide in the truck had been off-loaded into the acid tank, there could have been a violent chemical reaction that could have caused extensive personnel injury and equipment damage.

The sodium hydroxide was to be used in the plant’s water treatment system. When security notified the control room that acid was arriving, shift supervisors dispatched the operator and the trainee to off-load the truck. The operators obtained a copy of the station procedure for receiving sulfuric acid and went to meet the truck. When they arrived at the storage tank area, the equipment operator asked the driver if the truck contained acid. The driver responded that it did. He gave the equipment operator a copy of the shipment’s paperwork, but the operator did not read the manifest that described the cargo. The driver then attached a transfer hose to the sulfuric acid storage tank fill connection. Before the chemical transfer began, a security officer escorting the truck asked the trainee, “What is caustic acid?” The trainee, puzzled by the terminology, questioned the equipment operator, who again asked the driver to identify the truck’s contents. The driver replied, “Caustic acid.” The equipment operator then checked the driver’s manifest, discovered that the truck contained sodium hydroxide, and requested that the driver disconnect his truck from the acid storage tank.

Investigators determined the following contributing causes of this event and the potential consequences if the sodium hydroxide had been transferred into the acid storage tank.

- Security guards misinformed the control room that a truck of acid had arrived, and control room supervisors did not verify if a truckload of acid was scheduled for delivery.

- Equipment operators were not required by station procedures for off-loading acid and caustic to verify the contents of a tank truck before allowing the driver to connect the truck to the storage tank fill line.

- If the sodium hydroxide had entered the sulfuric acid storage tank, a violent exothermic reaction would have rapidly produced a large volume of steam as the caustic and acid neutralized each other. The storage tank might have failed and a cloud of acidic steam might have seriously injured nearby personnel and damaged equipment.

NFS has reported events where mixing incompatible chemicals has caused personnel injury and facility damage. Some examples follow.

- Weekly Summary 98-18 reported that an employee at the Lawrence Livermore National Laboratory received chemical burns to his face when a plastic bottle pressurized, ruptured, and sprayed its contents. Investigators determined that the bottle contained sulfuric acid, nitric acid, and acidified hydrocarbon oil, and that the employee's lab coat, shirt, and safety glasses protected most of his skin. Mixing incompatible materials resulted in an injury that could have been more serious had the employee not been wearing safety glasses. (ORPS Report SAN--LLNL-LLNL-1998-0025)

- Weekly Summary 97-29 reported a building evacuation at the Lawrence Livermore National Laboratory because of fumes generated by mixing a solution of nitric acid, hydrogen fluoride, and acetic acid with a solution of ethanol, hydrofluoric acid, and water. Investigators determined that the fumes resulted from a chemical reaction between incompatible materials being mixed for waste disposal by a technician. (ORPS Report SAN--LLNL-LLNL-1997-0037)

- Weekly Summary 96-40 reported that a researcher at the Oak Ridge Environmental Sciences Center was adding methanol to two vials containing sodium permanganate and polychlorinated biphenyls when an unexpected energetic reaction caused the mixture to spray from the vials. Approximately 1 ml of the mixture sprayed on the researcher's gloves. Investigators determined that an inadequate evaluation of chemical compatibility allowed the reaction to occur. (ORPS Report ORO--ORNL-X10ENVIOSC-1996-0001)

- Weekly Summary 95-52 reported the lessons learned from an event at the Oak Ridge K-25 Facility in which a 5-gal plastic container ruptured because of internal pressure from a chemical reaction. Although no one was injured, the force of the reaction and parts from the plastic container created a hole in the wall nearest the container and in the ceiling directly above it. The explosion occurred as a result of mixing nitric acid, acetone, and other organic waste. Lessons learned from the event indicated that procedures must clearly caution against the mixing of incompatible materials and the actions needed to ensure segregation of such materials. (DOE Lessons Learned List Server Item Number Y-1995-OR-LMES-K25-1201, ORPS Report ORO--LMES-K25-GENLAN-1995-0003)

Sulfuric acid and sodium hydroxide are commonly used in water treatment systems and for other purposes. Other chemicals and gases are also routinely delivered by truck for use by facility personnel. Facility managers should ensure that site procedures require verification that a truck delivering a liquid or gas is carrying the expected material and that the shipment's manifest is checked before the truck is allowed to connect or off-load to any facility system. The scheduled shipment of bulk chemicals should be routinely transmitted to security. Security personnel should verify a truck's contents by checking shipment manifests before communicating the information to the receiving organization. Personnel who use, transfer, or store acids or caustics and other chemicals and gases, especially laboratory workers and hazardous chemical waste handlers, should review the following references for guidance.

- DOE Defense Programs Safety Information Letter 96-01, *Incidents from Chemical Reactions due to Lack of or Failure to Follow Proper Handling Procedures*, states that both management and facility staff must emphasize safety and planning, particularly when working with acids or potentially reactive compounds, to prevent adverse reactions due to inadvertent or improper mixing.

- DOE Defense Programs Safety Information Letter 96-05, *Compatibility Considerations in the Mixing of Waste Chemicals*, contains information and warnings on mixing wastes during waste collection, commingling, and storage operations.

- DOE/EH-0557, Safety Notice 97-01, *Mixing and Storing Incompatible Chemicals*, contains lessons learned related to mixing incompatible chemicals, which can cause exothermic reactions or the generation of hazardous gases that can result in violent explosions.

- DOE/EH-0296, Bulletin 93-2, *Mixing of Incompatible Chemicals*, provides information about the consequences of mixing incompatible chemicals and calls for greater emphasis on how to eliminate such incidents and protect against their consequences should they occur.

KEYWORDS: acid, caustic, chemical reaction, communication, hazardous waste, industrial safety

FUNCTIONAL AREAS: Chemistry, Materials Handling/Storage

4. HIGH WINDS BLOW DOOR OFF WASTE STORAGE DOME

On June 9, 1999, at the Los Alamos National Laboratory Waste Management Facility, a radiological control technician (RCT) discovered that a 30-ft by 25-ft sliding door to a waste storage dome had been blown off. The door was severely damaged and two panels on the north side of the dome were also torn. The waste drums inside, which contain transuranic waste, were not disturbed. The RCT verified that all radiological postings were still in place and conducted a survey of the controlled area within the dome using a hand-held monitor. No activity was detected. Local maximum wind velocity was 31.8 mph and an instantaneous gust measurement taken at a meteorological station 1 km southeast of the area recorded 47 mph. The initial estimated replacement cost is $50,000. Although there was no impact on health, safety, or the environment, damage to waste storage domes and tents could expose radioactive waste containers to the environment. (ORPS Report ALO-LA-LANL-WASTEMGT-1999-0005)

The dome was built in 1994 for storage of Laboratory legacy waste. It is 250 ft long by 60 ft wide by 25 ft high and is constructed of aluminum ribs and cross members with vinyl panels that are 12 mil thick. The dome was manufactured by Sprung Instant Structures and is rated to withstand 77-mph winds. Each door weighs approximately 1,000 lb. The damaged door, which was located at the east end of the dome, has two triangular vinyl panels. The doors are connected to the dome at the top by a pivot hinge and they roll on the inside of the dome to open and close.

Figure 4-1 shows the damaged door and figure 4-2 shows the door location and the damaged panels.

Figure 4-1. Damaged Door

Figure 4-2. Dome with Damaged Panels

Every evening personnel check to ensure the doors on each dome in the area are closed. On June 8, the RCT who made the final sweep verified that the doors to the dome were closed. The dome door verification guidance requires that RCTs ensure the doors are closed but does not require a verification that they are latched. Records from a badge reader system indicate that the RCT who performed the sweep on June 8 was the last individual to exit the area that night.

Investigators determined that the door appeared to have been blown open at the southeast side or corner of the doorframe and been picked up by a strong gust of wind and to have lifted and landed on the roof of the dome. It then pulled loose of the pivot hinge and slid down the northeastern side of the dome, as is evident from the rubber marks on the side panels made by the door tires. The door eventually landed approximately 30 ft from the door opening, and a cross member of the door assembly landed approximately 35 ft from the opening of the door. Investigators believe the door was not latched closed on June 8. If the doors are not tightly shut there can be as much as a 2-in. gap. They believe that under the right conditions this small gap could allow the wind to push the door open enough for the wind to get behind it and an event such as this to occur.

Facilities-Solid Waste Management personnel inspected all other domes to ensure that they were secure. Any domes without latches will have external latches installed to make it easy to verify that the doors are latched. Personnel also rebuilt the damaged door frame so that the dome could be properly secured.

Many DOE facilities have reported damage to temporary storage facilities. On July 31, 1994, high winds from a thunderstorm damaged five containment tents at the Idaho Chemical Processing Plant. Investigators estimated the cost of the damage to be $145,000. (ORPS Report ID--WINC-WASTEMNGT-1994-0014) NFS has reported other events in the Weekly Summary involving wind damage to waste storage structures. Some examples follow.

- Weekly Summary 96-05 reported that a security guard at the West Valley Demonstration Project found a damaged temporary storage tent that housed 1,800 boxes of low-level contaminated soil and general waste. The tent had a modular frame with a tensioned membrane structure and was 291 ft long and 88 ft wide.

Before the damage was discovered, wind speeds ranged from 25 to 40 mph, with gusts to 64 mph. Investigators estimated the cost of the damage to be approximately $250,000. (ORPS Report OH-WV-WVNS-LAG-1996-0001)

- Weekly Summary 96-02 reported that 11 waste storage tents at Rocky Flats were damaged by gale-force winds. Investigators estimated the damage to be in excess of $470,000. (ORPS Report RFO--KHLL-WSTREPACK-1996-0001)

These events illustrate some of the problems associated with temporary structures. Because they are temporary, these structures may not be designed to the same standards as permanent ones, but the consequences of structural damage can be as severe. Also, wind damage can occur even at wind velocities well below the manufacturer's design maximum for the structure, if doors and access ways are not properly secured. Purchasers of temporary structures need to ensure they are adequately designed for winds, snow, and ultraviolet degradation. Managers at DOE facilities that have temporary storage structures should review these events to determine if their structures are adequately designed, maintained, and secured against wind damage.

KEYWORDS: damage, door, tent, waste storage, wind

FUNCTIONAL AREAS: Materials Handling/Storage

5. FALL FROM TANK INJURES CONTRACTOR

On June 10, 1999, at the Brookhaven National Laboratory, a contractor worker fell approximately 10 ft from the top of a storage tank, sustaining bruises and abrasions on his face, an arm, and a knee. Emergency medical team personnel transported him to a local hospital for treatment and observation. He was released the same day. The worker was on top of the tank to receive a hose from another worker on the ground when he fell. Fall protection was provided on top of the tank in the form of a platform and railings, but the worker went outside the fall protection area to retrieve the hose. Working outside areas where fall protection is provided or not wearing required fall protection equipment is dangerous and can result in injuries or fatalities. (ORPS Report CH-BH-BNL-BNL-1999-0015)

Contractor personnel were preparing to transfer a hose from a processing tank to the decontamination water storage tank (SCAT) for the purpose of filtering contaminated water in the storage tank. The contaminated water would then be pumped from the SCAT to a filtration system on the ground and then to a high-integrity container for testing and potential further treatment. The tank has been filled and emptied two times a year since 1997. The filtration work that started on June 7 was the first time the filtration system had been attached to the tank. Workers had performed hose hookups at the top of the tank several times without incident. The contractor field supervisor immediately stopped work on the water-processing task. The Environmental Restoration field engineer issued a stop-work for all work activities by that contractor.

The SCAT measures 12 ft long by 10 ft wide and 9 ft high. It has a fixed ladder that goes to a small (fall-protected) platform on top from which the tank ports can be accessed. Only the platform at the top of the ladder is fall-protected; the remainder of the tank is not designed to be occupied. Figure 5-1 shows the tank arrangement and location of the contractor before he fell.

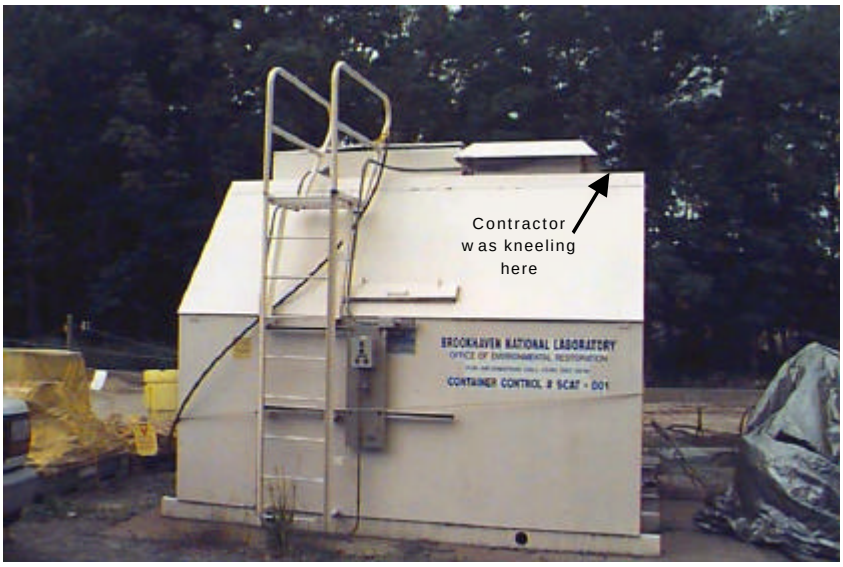

Figure 5-1. Storage Tank Configuration

Investigators determined that while the worker was on the tank, he held on to a vent pipe mounted on top of the tank as he reached for the hose. The vent pipe broke from its fitting, and the worker lost his balance and fell to the ground. He was fortunate that he did not land on top of the filtration system located next to the SCAT. Investigators also determined that the only way to pipe water from the SCAT to the filtration system was to attach hoses at the top of the tank. However, the contractor worker did not have to leave the fall-protected area to be able to do that. No fall protection was used other than the railings provided at the ladder and platform.

The project manager conducted a critique of the event. Critique members determined that poor work planning was a contributing cause, because elevated work areas were not identified as a potential safety concern before the job began. Managers are evaluating the job for improvements, and it will not continue until an appropriate method for attaching hoses to the tank has been determined.

OEAF engineers reviewed a final report this week on fall protection issues at the Hanford Spent Nuclear Fuels Project. The final report addressed several events that occurred from October 1998 through March 1999 in which personnel could have fallen into the 105 KW basin. Many of these events involved failing to tie off safety harnesses and crawling under a sign that read "Danger, Fall Protection Required Beyond This Point." Facility managers determined the direct cause of these events was human error, because workers were not fully aware of appropriate fall protection requirements. The root cause was inadequate administrative control, because management failed to implement a process to ensure workers recognized the need for fall protection. (ORPS Report RL--PHMC-SNF-1999-0009)

NFS has reported numerous other fall-related injuries in the Weekly Summary. Following are some examples.

- Weekly Summary 99-10 reported that a subcontractor at the Oak Ridge East Tennessee Technology Park fell through the roof of a one-story office structure, landing on a table 7 ft below. He received only abrasions and contusions. Investigators determined that a piece of plywood lying across some joists slid and allowed him to fall between the joists. The plywood was not fastened in place and the subcontractor was not using fall protection. (ORPS Report ORO--BJC-K25GENLAN-1999-0004)

- Weekly Summary 97-44 reported that a subcontractor pipe fitter at the Oak Ridge National Laboratory fell through a roof opening of a tank vault building and landed on wooden scaffold decking 15 ft below. As the pipe fitter walked on a temporary plywood cover for a hatch into the tank vault, it dislodged, allowing the pipe fitter to fall. (ORPS Report ORO--LMES-X10CM-1997-0005)

- Weekly Summary 97-42 reported that a safety inspector at the Los Alamos National Laboratory issued a stop-work order to a roofing subcontractor because of repeated fall protection violations. The inspector observed a subcontractor safety monitor assisting in roofing activities. OSHA regulations and contractor procedures require using a dedicated safety monitor who has no other responsibilities. (ORPS Report ALO-LA-LANL-LANL-1997-0002)

These events underscore the importance of ensuring that workers are informed of the hazards associated with falls before they work on top of structures or in elevated areas. Workers need to remain within fall-protected areas or use fall protection equipment. DOE facility managers should review the following requirements to ensure that employees are familiar with both site and OSHA requirements on fall protection when they are working on roofs, towers, tanks, stacks, and buildings.

Section 29 CFR 1926.502, "Fall Protection Systems Criteria and Practices," requires employers to provide and install fall protection systems for employees and to comply with all other pertinent requirements before employees begin the work that necessitates fall protection. OSHA states: "Each year, on average, between 150 and 200 workers are killed and more than 100,000 are injured as a result of falls at construction sites. OSHA recognizes that accidents involving falls are generally complex events frequently involving a variety of factors. Consequently the standard for fall protection deals with both the human and equipment-related issues in protecting workers from fall hazards." OSHA Publication 3146, *Fall Protection in Construction,* discusses general fall protection concepts; 29 CFR 1926, Subpart M; and fall protection systems including (1) covers, (2) guardrail systems, (3) personal fall arrest systems, and (4) safety net systems. It also discusses a mandatory training program for employees who might be exposed to fall hazards, including ways to recognize and minimize the hazards.

The OSHA publication can be obtained at http://www.osha-slc.gov/SLTC/fallprotection/index.html or by contacting the local, regional, or area OSHA office (listed in the telephone directory under U.S. Department of Labor) or writing to OSHA Publications Office, 200 Constitution Ave., NW, Room N-3101, Washington, D.C. 20210. OSHA regulations can also be found at http://www.osha-slc.gov/.

KEYWORDS: fall, fall protection, injury, tank

FUNCTIONAL AREAS: Industrial Safety

6. TUNNEL COVER PLATE DROPPED DURING ACCEPTANCE TESTING

On June 10, 1999, at the Argonne National Laboratory—West Hot Fuel Examination Facility, a hydraulically operated, 700-lb cover plate fell into the cask cart tunnel trench while an engineer and a computer programmer were performing acceptance testing of modifications to the trench. No personnel injuries resulted, and there was limited damage to the tunnel cover plate and hydraulic lines in the trench. Communications failures between the engineer and the computer programmer caused support hinges for the cover plate to raise, allowing the plate to fall 8 ft into the trench. The event resulted in damaged equipment and a delay in the testing schedule. (ORPS Report CH-AA-ANLW-HFEF-1999-0004)

The cask tunnel was recently modified to deepen it to accommodate commercial shipping casks. The tunnel cover plates act as a personnel floor over the open trench. Cover plates are lowered and lifted by a scissors hoist and are supported in the raised position by hinged supports on either side of the tunnel. When the cover plates need to be lowered, the scissors hoist lifts the plate off the hinged supports, the hinged supports are raised, and the scissors hoist lowers the plate into the tunnel. The hinged supports are also hydraulically operated. The hydraulic systems are automatically controlled by a programmable logic controller (PLC).

Investigators determined that the engineer and programmer were using procedures developed to test the movement of cover plates. The computer programmer was using a laptop computer to send signals to the PLC to simulate various cover plate and hinged support positions when the engineer moved the cask cart to a different position without telling the computer programmer. The combination of simulation signals and real signals resulting from the repositioning of the cask cart caused the PLC to send a signal to raise the hinged supports for one of the cover plates while it was being supported only by the hinged supports. When the supports raised, the plate fell into the bottom of the cask tunnel.

NFS has reported on similar occurrences in the Weekly Summary involving problems with acceptance testing. Following are some examples.

- Weekly Summary 98-22 reported that the radiobioassay senior coordinator at the Mound Plant discovered a discrepancy in quality control parameters for bioassay activity calculations used by a new alpha spectrometric system. Investigators determined that the acceptance process used by the Bioassay Laboratory for the new system was inadequate. (ORPS Report OH-MB-BWO-BWO04-1998-0002)

- Weekly Summary 98-04 reported that a compressor at the Mound Tritium Emissions Reduction Facility may have been damaged because acceptance testing procedures were inadequate. Investigators determined that the acceptance testing procedures were inadequate because they lacked any requirements to test safety shut-down devices for the compressor. (ORPS Report OH-MB-EGGM-EGGMAT01-1998-0001)

These occurrences underscore the importance of good communications and attention to detail when more than one person is performing tests on a complicated system. The rigor normally applied to good conduct of operations concepts may be lacking for infrequent evolutions such as acceptance testing. The following references provide additional information on the topics of acceptance testing and communications.

- DOE 5700.6C, *Quality Assurance*, specifies the criteria for inspection and acceptance testing. These criteria discuss controls for selection, determination of suitability, evaluation, receipt of purchased items, and evaluation of prospective suppliers. The inspection and acceptance testing criterion states that a process

should be established and implemented to specify when to inspect procured items and what type of inspection is required.

- DOE-STD-1031-92, *Guide to Good Practices for Communications*, discusses the need for clear, formal, and disciplined communications and provides guides for improving communications.

KEYWORDS: certification, inspection, test

FUNCTIONAL AREAS: Instrumentation and Control, Procurement

7. IMPROPER SAFETY LOCKOUT CAUSES NEAR MISS

On June 4, 1999, at the Rocky Flats Plutonium Fabrication Pyrochemical Facility, maintenance electricians locked out the wrong circuit breaker for a ventilation fan while they were preparing for preventive maintenance to be conducted by maintenance machinists. Stationary operating engineers (SOEs) noticed that a standby fan started automatically and concluded immediately that the wrong fan had been de-energized. They contacted the configuration control authority, who then tried to contact the maintenance electricians who had locked out the fan. In the meantime, and as a routine practice, the maintenance mechanics assigned to the job checked with the SOEs just before beginning work on the fan. The SOEs warned them that the wrong fan had been locked out and told them not to perform any maintenance. Although no maintenance was performed and no injuries resulted from this occurrence, the facility manager considered it a very serious near miss. Failure to lock out the correct fan could have exposed personnel to 480 V ac as well as to a rotational hazard. Ventilation fans are interlocked and may start at any time without warning. (ORPS Report RFO--KHLL-PUFAB-1999-0031)

Facility personnel removed the incorrect lockout from the fan breaker and restored the ventilation system to a normal lineup. The facility manager convened a fact-finding meeting, and attendees learned the following.

- The lockout/tagout permit and the tags accompanying the permit designated the correct breaker, and the correct breaker had been discussed by the electricians during a pre-evolution briefing. However, the job supervisor had attached an uncontrolled, poorly duplicated one-line drawing to the lockout/tagout permit with the incorrect breaker circled.

- In violation of the site conduct-of-operations manual, which requires the acts of isolation and independent verification to be separated by time and space, the isolator and the verifier worked together to apply the lockout. Both the isolator and the verifier used the drawing with the incorrectly circled breaker to identify the breaker to be locked out; neither referred to the lockout/tagout permit or the lockout tags, although both initialed them.

- When he was notified by the SOEs that the wrong breaker had been locked out, the configuration control authority focused his efforts on contacting the maintenance electricians who had applied the lockout, and he failed to make timely notification to the maintenance mechanics who were to conduct the work. This condition persisted for approximately 1½ hours.

Corrective actions developed so far include reinforcing the requirement that only controlled, clearly reproduced drawings are to be used with lockout/tagout permits; conducting toolbox reviews of the occurrence; reviewing the requirements for independent verification with all qualified isolators and verifiers; and emphasizing the need for correct, immediate response in emergency situations to minimize the potential for personal injury. Corrective actions also included personal and confidential disciplinary actions for four personnel who contributed to this occurrence.

NFS has reported other events where the wrong circuit breaker or piece of equipment was locked and tagged, exposing personnel to a hazard. The following are among them.

- Weekly Summary 99-14 reported that on April 1, 1999, a maintenance mechanic at the Savannah River H-Canyon Facility replaced a pressure gage in the wrong system under an improper lockout. The mechanic had replaced a gage in a 90-psi instrument air system, but the repair procedure relied on a lockout for a steam system. Investigators determined that the operations maintenance coordinator mistakenly identified the component number for an instrument air gage instead of the intended steam pressure gage and wrote a work plan that required hazardous energy isolation for steam. However, work controllers assigned the work package to an existing lockout for process air. Later, a maintenance lead supervisor reassigned the work package to an existing lockout for the steam system without walking down the job and without notifying the shift operating manager. At the job site, the mechanic assigned to replace the steam gage realized that the gage identified in the work package was in the air system and not in the steam system. He concluded that the work package originator had made a simple mistake and he replaced the air gage without informing anyone of the discrepancy. As a result, he not only replaced the wrong gage but replaced it without a lockout to control the hazard. (ORPS Report SR--WSRC-HCAN-1999-0019)

- Weekly Summary 98-48 reported that on November 19, 1998, electricians at the Los Alamos National Laboratory Chemistry and Metallurgy Research (CMR) Facility had applied a safety lockout/tagout to the wrong circuit breaker in support of pump replacement work. After completion of the work and during removal of the lockout/tagout, CMR operations personnel found that the electricians had applied the lock and tag to a circuit breaker that was not connected to the pump. The lockout order required a red safety lock to be placed over a blue configuration control lock; however, the electricians had placed it on the wrong breaker even though there was no blue lock on the breaker. The area work supervisor delegated his responsibility for independent verification of the lockout to one of the electricians. The electrician misunderstood his instructions and did not properly verify the lockout in accordance with the lockout order. (ORPS Report ALO-LA-LANL-CMR-1998-0042)

Lockout/tagout programs in DOE serve two functions. The first function, defined in 29 CFR 1910, *Occupational Safety and Health Standards*, and in DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities,* is to protect personnel from injury and protect equipment from damage. The second function is to provide overall control of equipment and system status. The standard states that an effective lockout program requires three elements: (1) all affected personnel must understand the program, (2) the program must be applied uniformly in every job, and (3) the program must be respected by every worker and supervisor.

These occurrences underscore the importance of applying disciplined conduct of operations to the implementation of lockout/tagout programs. At the Rocky Flats Plutonium Fabrication Pyrochemical Facility, personal injury was narrowly averted by the alertness of the stationary operating engineers and the good practice of checking with operating authorities just before beginning a maintenance activity. However, distributed among these events are failures to apply lockouts in strict accordance with lockout permits, failures to perform proper independent verifications, violations of lockout/tagout program requirements, failures in communication, and failures to stop work when confronted by uncertainties or conflicts.

A properly executed independent verification is one of the most effective barriers to an incorrect lockout. DOE-STD-1036-93, *Guide to Good Practices for Independent Verification,* and DOE/EH-0502, Safety Notice 95-02, *Independent Verification and Self-Checking,* contain guidelines for designing and implementing independent verifications. Safety Notices are available at http://tis.eh.doe.gov:80/web/oeaf/ lessons_learned/ons/ons.html.

KEYWORDS: conduct of operations, lockout and tagout, maintenance

FUNCTIONAL AREAS: Conduct of Operations, Industrial Safety

8. CONDUCT-OF-OPERATIONS VIOLATIONS PROMPT SAFETY STAND-DOWN

On June 14, 1999, the Nevada Test Site facility manager reported multiple conduct-of-operations violations at the Device Assembly Facility that occurred during maintenance on an air conditioning unit on February 12, 1999. The violations included working beyond the scope of authorized work, failure to perform a job hazard analysis, failure to obtain a required lockout/tagout, and improper removal of a craft safety lock. The facility manager directed a safety stand-down to notify appropriate personnel of the occurrence and lessons learned. This occurrence is significant because work performed without adequate safety hazard analysis and worker protection could have resulted in personal injury. (ORPS Report NVOO--BNLV-NTS-1999-0014)

Two refrigeration mechanics had been tasked with troubleshooting, repairing, and performing preventive maintenance on an air conditioning condenser. The troubleshooting element of the job did not require a lockout/tagout permit because it did not involve working near energized electrical circuits or overriding safety devices. The shift supervisor authorized the mechanics to conduct the troubleshooting.

After the mechanics identified the problem, they undertook repairs without obtaining proper work authorization, without performing the pre-task hazard review as required by a change in work scope, and without a lockout/tagout permit. They opened the power disconnect for the system and installed a refrigeration craft lock on the power panel. The repair work involved charging the system with Freon, which required an electrical jumper in the control circuit to establish a flow path for the Freon. They contacted an electrician, who installed the jumper. The electrician noted the craft lock on the disconnect but neither questioned the absence of a lockout tag nor applied his personal lock to the disconnect.

The refrigeration mechanics re-energized the system and introduced the Freon. This activity did not produce the desired effect. They de-energized the system, re-installed their craft lock, and discussed the problem with their foreman. The mechanics returned to the system control panel while the foreman actuated a pneumatic switch he thought might assist the Freon flow. The foreman then removed the craft lock from the power panel and re-energized the system without informing the mechanics.

The mechanics realized that the panel had been re-energized when they heard a solenoid actuate. Disturbed that the control panel had been re-energized without their knowledge, the mechanics closed the control panel and stopped their work. They discussed the event with the foreman and reported it to the maintenance superintendent. They also notified an electrical foreman that the previously installed jumper could be removed. Again, the electrician removed the jumper without questioning the absence of a lockout tag and did not install his personal lock on the disconnect.

Facility management conducted two separate investigations before correctly identifying all of the event causes. They identified the direct cause as personnel error, because the work crew exceeded its work authorization. They identified the root cause as a management problem, because managers had not adequately established their expectations for compliance with conduct-of-operations requirements at the facility. Contributing causes included failure to conduct a pre-task hazard review, failure to obtain a lockout/tagout permit for the repair work, and failure to provide conduct-of-operations training for craft workers and supervisors.

Facility managers administered disciplinary actions for the personnel involved in this occurrence. Additional corrective actions will include the following.

- Conduct a safety stand-down to discuss the events surrounding the procedural violations, to review the lockout/tagout procedure, and to conduct on-the-job training using lockout/tagout scenarios.
- Continue to emphasize at monthly safety meetings the importance of complying with lockout/tagout procedures and pre-task hazard reviews.
- Ensure that workers at all levels take active roles in pre-task hazard reviews.
- Develop and administer a conduct-of-operations training program for all craft and supervisory personnel.

KEYWORDS: conduct of operations, integrated safety management, lockout and tagout, training

FUNCTIONAL AREAS: Conduct of Operations, Industrial Safety, Training and Qualification

9. JACKHAMMER PENETRATES CONDUIT CONTAINING HYDRAULIC LINES

On June 9, 1999, at the Los Alamos National Laboratory, laborers struck and penetrated a 3-in. polyvinyl chloride (PVC) line that contained hydraulic lines with a working pressure of 1,400 psi. The hydraulic lines were not damaged, but there were two 1-in.-diameter holes in the PVC conduit. The laborers were excavating for the replacement of the main gate of the Plutonium Handling and Processing Facility. Work planners failed to tell the laborers about the hydraulic lines, which control the position of vehicle entry/exit barriers. Although the hydraulic lines were not damaged, the facility manager designee considered the incident a near miss because the high pressure in the hydraulic system could have resulted in personnel injury. (ORPS Report ALO-LA-LANL-TA55-1999-0035)

A utility locator crew was tasked with locating buried utilities before starting the work. They identified buried utilities that conducted an electrical charge. They also used ground-penetrating radar (GPR), which determined that an electrical power line was present approximately 3 ft underground. The crew marked the location of the identified electrical utilities on the asphalt with spray paint. Because the PVC conduit and the hydraulic line did not contain any metal, they were not identified by utility locator equipment or the GPR. As-built drawings indicated that the hydraulic lines ran parallel to the electrical line, and work planners assumed they were at the same depth as the electrical line. However, the hydraulic lines and PVC conduit were buried only 8 in. deep and were covered by a concrete cap. The density of the concrete cap hid the lines from the GPR.

As part of the process for replacing the main gate, holes had to be dug by hand to help survey for utilities. As the hand digging progressed, the laborers found a stretch of concrete going from one end of the hole to the other in the location marked as the electric line. The laborers knew that there was an electric line at a depth of 3 ft, and because their hole was to be only 2 ft deep, they began to jackhammer the concrete to remove it. The laborer operating the jackhammer said that he felt the jackhammer hit something soft and stopped work. When the broken concrete was removed, the PVC conduit was found. Two holes were discovered in the conduit as a result of the jackhammering. A third hole was drilled to inspect the hydraulic lines, but no damage was found.

Investigators determined that work planners had performed a hazard screen and developed an activity hazard analysis (AHA) and that the laborers involved in the excavation had reviewed and signed the AHA. The job required the use of personal protective equipment (PPE) while jackhammering in the event that an unknown power source was hit. The PPE included dielectric gloves and boots, which the laborer who operated the jackhammer was wearing at the time of the incident. The location of the identified utilities was reviewed at a pre-job meeting, but the review did not address the location of the hydraulic lines. Investigators also determined that the hydraulic lines were replaced approximately 5 months earlier, so their exact location and depth would have been known and should have been marked on the as-built drawings.

NFS has reported other excavation events in the Weekly Summary in which gas lines, water pipes, and electrical utilities were struck by excavating equipment, digging bars, drills, and jackhammers. Some examples follow.

- Weekly Summary 99-21 reported that a subcontractor backhoe operator punctured a buried 6-in., 55-psi natural gas line while excavating to install a drainpipe for an electrical vault at the Federal Energy Technology Center. The subcontractor failed to follow procedures that required him to locate the pipeline, mark its location before digging, and use hand tools to locate the pipeline. (ORPS Report HQ--GOPE-FETC-1999-0004)

- Weekly Summary 97-11 reported that a subcontractor worker struck an energized 120-V electrical cable while drilling into a concrete floor at Brookhaven National Laboratory. He saw sparks but was not shocked or injured. Investigators determined that work planners did not identify the location of the cable before drilling started and that the as-built drawings for buried electrical conduit runs did not show the exact location of the conduits. (ORPS Report CH-BH-BNL-PE-1997-0003)

- Weekly Summary 96-42 reported that jackhammer operators struck three conduits while working on a concrete dock inside a building at the Rocky Flats Environmental Technology Site. The subcontractor assumed that the prime contractor had verified that no utilities were located beneath the concrete. (ORPS Report RFO--KHLL-REGWSTOPS-1996-0005)

- Weekly Summaries 96-04 and 96-05 reported that a mason tender at Los Alamos National Laboratory received a severe electrical shock that resulted in serious burns and cardiac arrest. He was excavating through a concrete floor in a building basement when his jackhammer contacted an energized 13.2-kV electrical cable. (Type A Accident Investigation Board Report on the January 17, 1996, Electrical Accident with Injury in Building 209, Technical Area 21 Los Alamos National Laboratory; ORPS Report ALO-LA-LANL-TSF-1996-0001)

These events illustrate the importance of using every available means to locate buried utilities and other hazards before beginning excavation. As-built drawings should reflect the location and depth of all underground utilities and services. During and following excavation work, as-built drawings should be updated to indicate measurements for location and depth. Other sources of information such as construction documents and installation specifications may provide appropriate information. The use of locating equipment is very helpful, but even these devices have their limitations. In the Plutonium Handling and Processing Facility event, the recent work that had been performed on the hydraulic lines could have provided information and prevented the event. Following are some references that facility managers, program and project managers, and project personnel should review on excavation.

- DOE/EH-0541, Safety Notice 96-06, *Underground Utilities Detection and Excavation*, provides descriptions of recent events, an overview of current technology for underground utility detection, specific recommendations for improving site utilities detection and excavation programs, and information on innovative practices used at DOE facilities.

- 29 CFR 1926, *Safety and Health Regulations for Construction,* paragraphs .651(b) and .416(a)(3), make employers responsible for identifying underground hazards and energized circuits near the work area. The requirements of 29 CFR 1926.965(c) state that work must be conducted in a manner to avoid damage to underground facilities.

Safety Notice 96-06 can be obtained by contacting the ES&H Information Center, (301) 903-449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874, or at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: buried, construction, excavation, hydraulic, underground, utility

FUNCTIONAL AREAS: Construction, Industrial Safety, Work Planning

OEAF FOLLOW-UP ACTIVITY

1. OPERATING EXPERIENCE WEEKLY SUMMARY TO BE AVAILABLE VIA E-MAIL

The Office of Nuclear and Facility Safety will soon be able to send a .pdf version of the OEWS directly to your e-mail. Here are just a few benefits you'll see when you have an electronic copy sent “straight to your desktop.”

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